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PHENOLOGY AND PHYSIOGNOMY OF THE HYDROPHYTE COMMUNITY IN OTSEGO LAKE, N.Y.

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As part of a biological survey conducted in 1969, the species and distribution of aquatic macrophytes in Otsego Lake, Otsego Co., N.Y., were determined (Harman 1970). The 1969 information was compared with data collected by Muencher (1936) in 1935 (Harman & Doane 1970). Emergent plants were more abundant in 1969 than in 1935. The number of species present in the lake had decreased between 1935 and 1969 and an introduced species, *Potamogeton crispus* L., that was not present in 1935, was the most obvious plant in the lake in early summer of 1969. The reduction in species in this lake is similar, although not as pronounced, as changes observed over 50 years in Oneida Lake, N.Y. (Harman & Forney 1970) and over 70 years in Put-in-bay Harbor, Lake Erie, Ohio (Stuckey 1971).

During the summer of 1969 it was noted that the zoobenthos and zoo-meroplankton populations underwent drastic fluctuations that correlated with the phenology of the aquatic macrophytes and the seasonal changes in the physiognomy of the plant community. A study was initiated to more accurately determine the composition of the flora at various times during the year so that we could quantitatively ascertain its effects on the associated fauna. The purpose of this report is to describe the seasonal changes in

the appearance of the littoral zone in Otsego Lake at Rat Cove, at the SUNY Oneonta Biological Field Station at Cooperstown, New York.

METHODS

In 1970, a transect about 500 m long was plotted from the end of our docks through the littoral zone, to the deeper water beyond. Plants growing along this line were measured by divers each week, from 1 June through 2 September, to determine the emergence time of the spring cohorts, greatest maximum heights attained, times of flowering, and times of death and decomposition of each species (Harman 1971). Because all growth represented even-aged stands, sufficient data were obtained by measuring the tallest individual plants of each species each week. It was impossible to measure the same individuals throughout their existence because the act of measurement disrupted, if not destroyed these fragile organisms. Also, movements along the transect disturbed the sediments so that by the end of September we had to move farther and farther away from the original line in order to measure plants in an undisturbed environment. Secchi transparency and surface water temperatures in Rat Cove were recorded from 15 June through 25 August.

In 1971 the same procedures were followed with these changes and additions. Samples were taken through the ice on 5 February. Weekly observations were initiated shortly after the ice breakup (22 April) and continued until 16 December after all plants had completed their seasonal growth. The transect was marked with an anchored hand line for divers to follow in order to alleviate the problems of getting lost in the often turbid water as had happened a few times in 1970. Secchi transparency and surface water temperatures in Rat Cove were recorded weekly from 10 May 71 until 3 January 72.

Samples of benthic organisms were taken near the transect at depths of 1-2 m, 3-5 m, and 6-8 m each week, to

determine and correlate seasonal changes of the macrobenthos with those of the aquatic plants. Likewise, number 20 plankton nets were carried by divers through the macrophytes occurring at 1-2 m, 3-5 m, and 6-8 m depths each week, to correlate the successional changes in the zooplankton community associated with them. The data resulting from these observations will be reported in a manuscript now in preparation.

Surface temperatures were essentially the same for both 1970 and 1971 (high = 24°C; mean for June, July, and August = 21.0 and 21.2°C, respectively). Mean Secchi transparency for June, July, and August was 4.4 m in 1970 and 4.3 in 1971. One appreciable difference in transparency was noted in June, the time that many of the plants were growing most actively. In 1970 the mean Secchi transparency was 5.3 m, in 1971, 4.2 m (Harman 1972).

PHENOLOGY AND PHYSIOGNOMY

The zonation of hydrophytes according to water depth, i.e., emergents, floating leaved varieties, and submergents (e.g., Sculthorpe 1967), is common knowledge. The components of the submergent macrophyte flora also occur in similar patterns, presumably because of the varying compensation points of each species relative to decreasing light intensity in deeper water, or to their growth in the shade of other species, and to the severe competition for space on eutrophic littoral substrates.

In any one area along the Rat Cove transect, between 50 cm and 550 cm in depth, several species of hydrophytes usually occur. This often results in a complex physiognomy exhibiting an overstory (usually of low density), a moderately dense intermediate stratum, and a low, very dense understory, although up to 7 distinct strata may be present. Vertical stratification of the community is continually changing during the growing season as the various species of macrophytes emerge from the substrate, attain maximum height and density, and then decompose.

The shallowest waters along the transect are barren because of the action of the waves on the shore. *Nuphar variegatum* Engelm., the yellow water lily, grows in scattered clones in water from 20 to 60 cm in depth in association with *Elodea canadensis* Michx. and *Megalodonta Beckii* (Torr.) Greene. Water from 50 cm to 500 cm in depth maintains all the remaining macrophytes studied except for *Nitella flexilis* (L.) C. A. Agardh and *Potamogeton crispus* which occur in water from 500 to 700 cm in depth.

The growth of macrophytes in 1971 was similar to that observed in 1970 with the following exceptions: *Potamogeton crispus, P. Richardsonii* (Ar. Benn.) Rydb., and *P. illinoensis* Morong reached heights of approximately 300 cm in 1970, but attained less than 250 cm in 1971 before decomposition began. In 1969 and 1970 *Potamogeton crispus* reached the surface in some areas of the lake forming dense beds that hindered navigation, but did not reach the surface anywhere in 1971. After the spring cohort of the pond weeds mentioned died back in 1970, comparatively few scattered plants were observed during the rest of the summer. In 1971, after the first cohort decomposed, many individuals resumed growth and died back sporadically until October.

The following are descriptions of the phenology and physiognomy of the plants at 4 sites (0.5 m, 2.0 m, 4.0 m, and 5.5 m in depth) along the transect (Fig. 1).

WATER DEPTH 0.5 M: *Nuphar variegatum* emerged from the substrate the first week in May; by 15 June, 1971 the leaves had reached the surface. They remained there until decomposed in early September. *Elodea canadensis* and *Megalodonta Beckii* started their seasonal growth in late April and the middle of May respectively. They maintained a maximum height of about 30 cm beneath the *Nuphar* during August. By 15 September *M. Beckii* had collapsed to the bottom and was decomposing. At the same time, *E. canadensis* started to decompose from the base and the entire plants became very brittle. By 15 November the

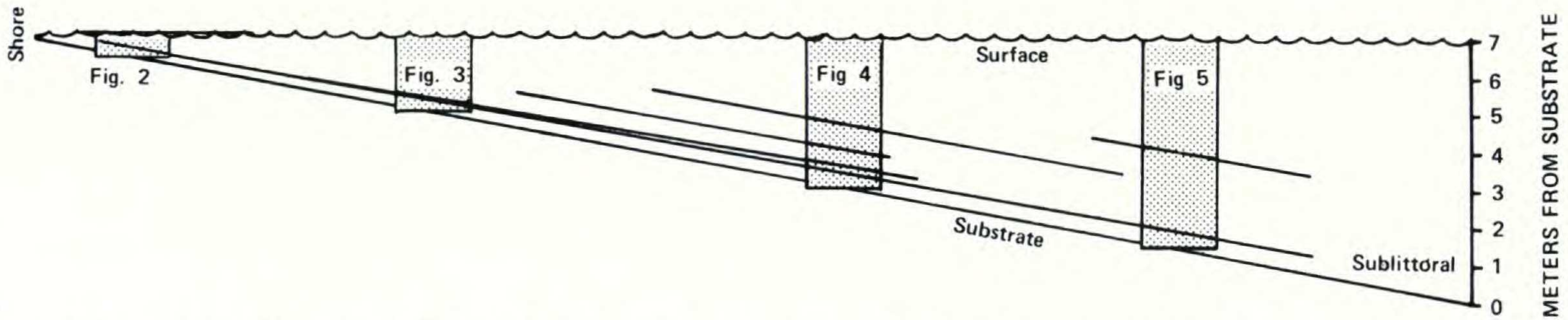

Figure 1. Diagrammatic profile of Rat Cove transect showing locations of figures 2-5. Horizontal lines indicate heights of dominant vegetation on July 15, 1971.

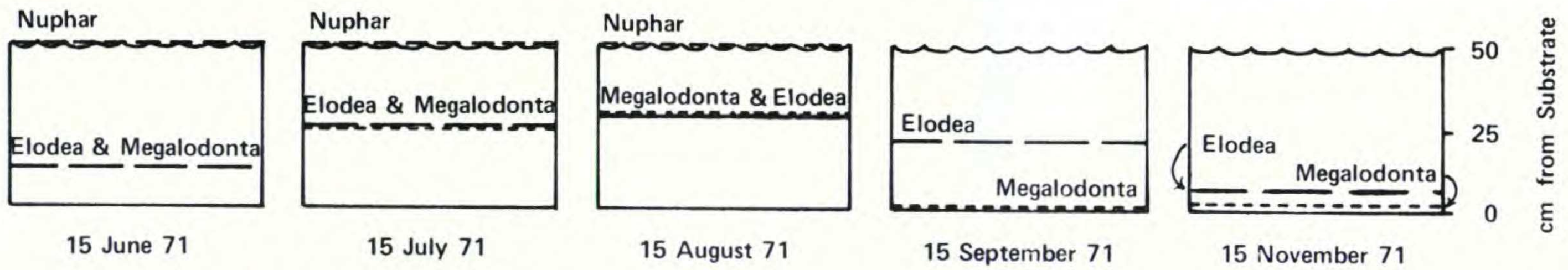

Figure 2. Water column 0.5 m in depth in Rat Cove, Otsego Lake, showing heights of abundant hydrophytes at selected dates. - - - = diffuse canopy: ——— = dense canopy.

winter condition was reached. *Megalodonta Beckii* and *E. canadensis* were prone on the bottom with winter buds 1 to 2 cm long developing at the nodes.

During July and August, two obvious layers of vegetation were present, *Nuphar variegatum* at the water's surface and *Elodea canadensis* and *Megalodonta Beckii* below. From autumn into the winter there were no actively growing macrophytes at this site. Figure 2 illustrates these changes at five selected dates during the year.

WATER DEPTH 2.0 M: This site was always dominated by dense stands of *Chara vulgaris* L. Only in June was *Megalodonta Beckii* able to emerge above this species. *Elodea canadensis* occurred only slightly higher than the *Chara* in June, July, and August before dying in the fall. In late August and early September *Najas flexilis* (Willd.) Rostk. & Schmidt was present, but never grew higher than the *Chara*. During August and September there were two definite vegetational strata present. A diffuse overstory of *Vallisneria americana* Michx. and *Myriophyllum exalbescens* Fern. occurred above *C. vulgaris*. With the decomposition of *V. americana* and *M. exalbescens* in November, only *Chara* remained.

The first week in May dense stands of *Chara vulgaris* were at their lowest height of the entire year. *Chara* grew steadily until the middle of November, when the plants started to decrease in size, presumably from basal decomposition, since the apices remained healthy all winter. *Megalodonta Beckii* and *Elodea canadensis* started growth at the same time as in the shallower water but attained somewhat greater heights. *Megalodonta Beckii* reached approximately 35 cm in height in August, decomposing in September. *Elodea canadensis* attained about 75 cm in height in early September and then began decomposing. *Myriophyllum exalbescens* appeared in early May, grew steadily until September and then fell to the bottom with new shoots appearing at the nodes. *Vallisneria americana* emerged from the substrate the middle of June, grew more rapidly

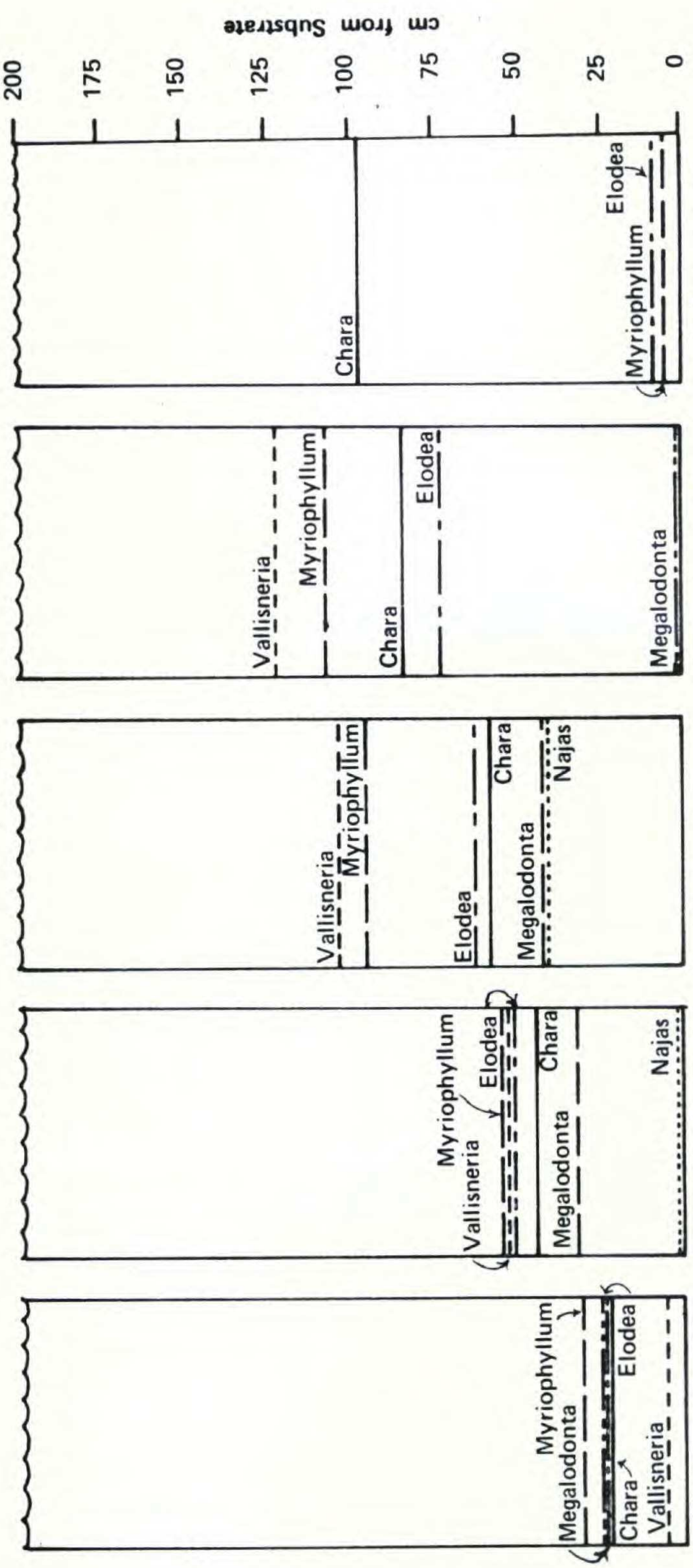

Figure 3. Water column 2.0 m in depth in Rat Cove, Otsego Lake, showing heights of aquatic hydrophytes at selected dates. - - - = diffuse canopy: ——— = dense canopy.

than its competitors, attaining its maximum height of about 125 cm in September, and then rapidly decomposed. *Najas flexilis* emerged from the substrate in the middle of July, grew rapidly to about 60 cm high in early September and disappeared. Figure 3 shows the strata in 2.0 m of water at various times during 1971.

WATER DEPTH 4.0 M: As at the 2 m site *Chara vulgaris* grew in dense beds at a consistent rate throughout the summer. *Elodea canadensis* was present until August as before. Early in May *Potamogeton pusillus* L., *P. zosteriformis* Fern., *P. Richardsonii,* and *P. illinoensis* emerged from the substrate. By 15 July *P. Richardsonii* and *P. illinoensis* attained about 200 cm in height while *P. pusillus* and *P. zosteriformis* reached only about 100 cm heights. All of the species of *Potamogeton* were decomposing by August, although a second cohort of *P. Richardsonii* remained until early September. In late May, *Heteranthera dubia* (Jacq.) MacM. emerged from the substrate and maintained steady growth until late September when it collapsed to the substrate.

In June the morphology of the plant community was very complex with 7 species of actively growing hydrophytes all at different heights in the water column. By July 3 obvious strata were present: a diffuse overstory composed of *Potamogeton Richardsonii* and *P. illinoensis,* a discontinuous stratum of intermediate height composed of *P. pusillus* and *P. zosteriformis,* and a dense understory of *Chara, Elodea* and *Heteranthera.* In September this same area was entirely different in appearance with 2 major strata present. There was a rather dense overstory of *Heteranthera dubia* underlain by *Chara vulgaris.* By November the *Chara* was all that remained. Figure 4 illustrates the physiognomy at this depth at several selected dates.

WATER DEPTH 5.5M: In these deeper waters *Nitella flexilis* replaced *Chara vulgaris.* Dense beds attaining 95 cm occurred in this area. The only macrophyte associated with this alga was *Potamogeton crispus,* which ap-

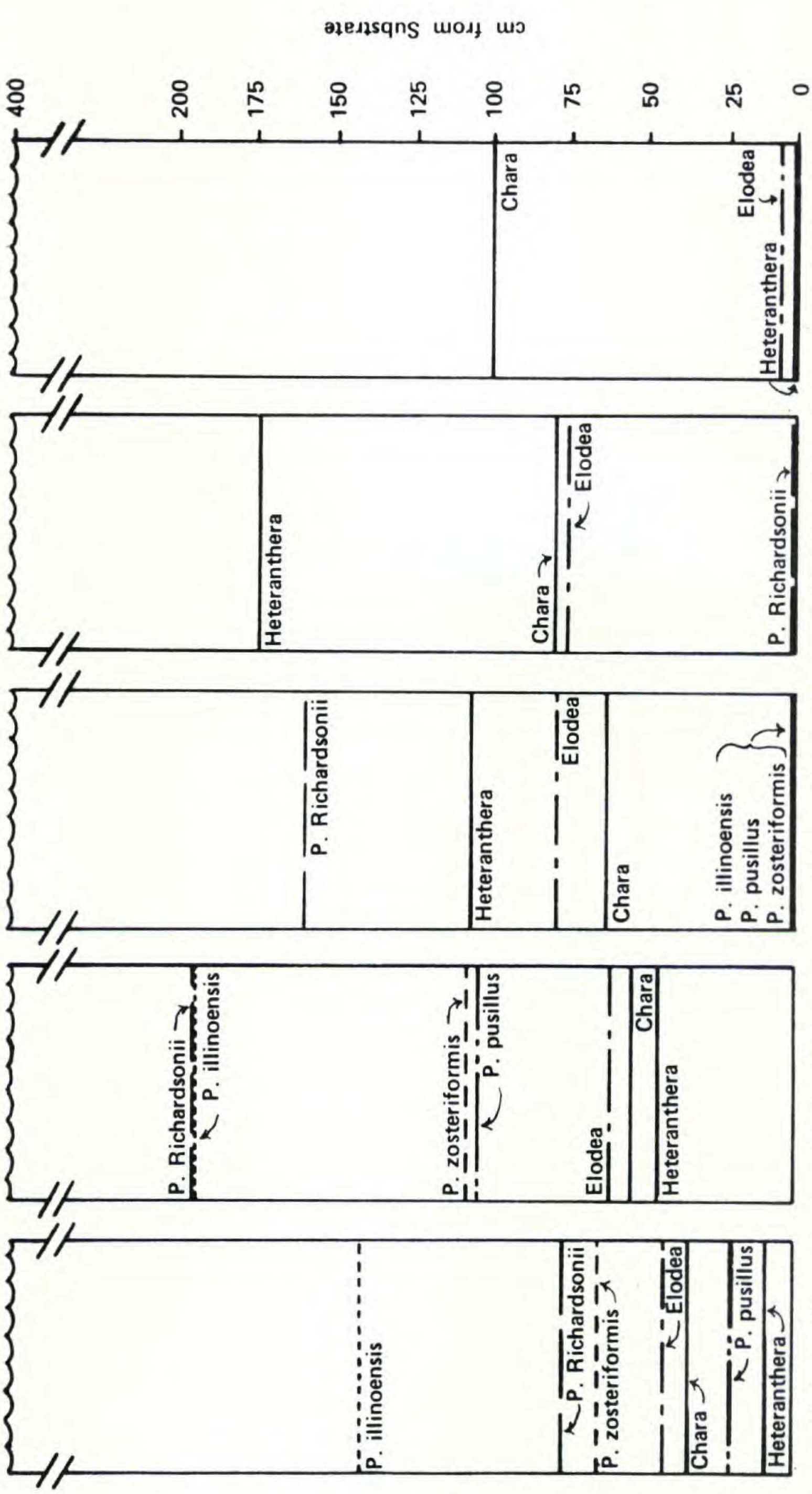

Figure 4. Water column 4.0 m in depth in Rat Cove, Otsego Lake, showing heights of abundant hydrophytes at selected dates. - - - = diffuse canopy; —— = dense canopy.

peared from the substrate the first week in May. The latter species grew extremely rapidly, attaining about 250 cm in height by the middle of July. It then collapsed to the substrate and decomposed.

In June and July two definite layers of vegetation were present at these depths. *Potamogeton crispus* formed a diffuse overstory while *Nitella flexilis* composed a dense understory. From August on into the winter *N. flexilis* was the only species present at the site (Fig. 5).

The macrophytes studied can be separated into four groups according to their morphology during the winter season. These characterize the appearance of the substrate during this period and provide food and cover for the local benthos. Group 1. *Chara vulgaris, Nitella flexilis.* Once maturity is reached the oldest parts of these algae are continually decomposing. During the winter period entire stands decrease in height as the rate of decomposition greatly exceeds the rate of growth. The apical meristems remain in a healthy condition throughout the year. In early spring much new growth is added from germinating oospores that cannot be distinguished from the older plants remaining during the same time periods. Group 2. *Myriophyllum exalbescens, Elodea canadensis.* When these organisms decompose (late September and late August, respectively), the old growth lays on the substrate and winter buds, 2-3 cm in height, appear at once from the nodes. These grow extremely slowly over the winter reaching 4-6 cm by early May. At that time the roots have become established, internodal tissues from the parent plants have rotted away and the new plants grow rapidly until the fall when the process is repeated. Group 3. *Heteranthera dubia.* Like the organisms in Group 2, this plant collapses to the bottom in a living condition (in mid-October) but the new shoots do not appear at the nodes until late May or early June of the next year. They grow rapidly until fall and the cycle begins again. The parent stems remain intact throughout much of the growing season. Group 4. *Potamogeton crispus, P. Richardsonii, P. illinoensis, P. zosteriformis, P.*

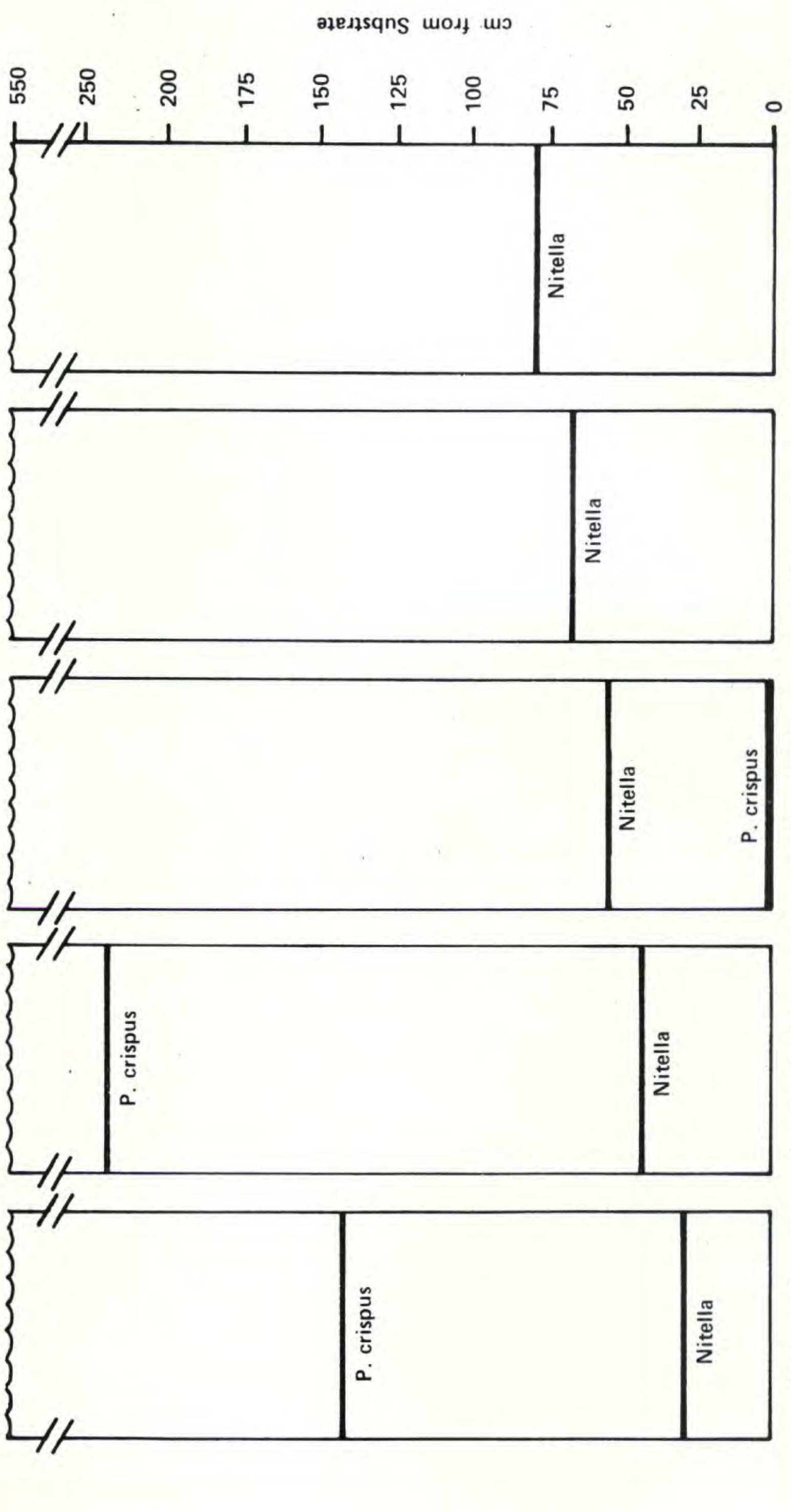

Figure 5. Water column 5.5 m in depth in Rat Cove, Otsego Lake, showing heights of abundant hydrophytes at selected dates. – – – = diffuse canopy: ——— = dense canopy.

pusillus, Vallisneria americana, Najas flexilis, Megalodonta Beckii, Nuphar variegatum. This group contains all the remaining plants studied. These macrophytes grow rapidly from buried winter buds or underground stems or root-stocks and then decompose, shoots not appearing above the substrate until the next growing season.

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